TESTIMONY OF JOHN W. MARTIN

1. Q. Please state your name, business address, and position with respect to the petitioning company.

A. My name is John W. Martin. My business address is 25 Research Drive, Westborough, Massachusetts. I am a Principal Engineer in the Transmission Planning department for the National Grid USA Service Company, which performs engineering and other services for National Grid USA companies, which includes the petitioning company, New England Power Company (NEP). Our department is responsible for transmission system planning, which includes determination of need for reinforcement of the bulk supply system, evaluation of alternative solutions, and selection of the most satisfactory solution.

2. Q. Are you a Registered Professional Engineer in the Commonwealth of Massachusetts?

A. Yes, I am.

3. Q. Have you previously testified and given a statement of your qualifications in proceedings before this Department?

A. Yes, I have testified previously in proceedings before this Department, specifically concerning the Ward Hill Substation in dockets DPU 92-278, 92-279, and 92-280.

4. Q. Will you outline your qualifications to testify on behalf of New England Power Company in this case?

A. I am a graduate of the Massachusetts Institute of Technology, holding a Bachelor of Science degree in Electrical Engineering; I am also a graduate of Northeastern University, holding a Master of Science degree in Electrical Engineering. I have over twenty years of experience in power system planning and analysis. I have been a Principal Engineer in the Transmission Planning department since April of 1998; prior to that I was a Senior Engineer in the department since its inception in June of 1993. Prior to that, I was an Engineer in the Transmission and Supply Planning

department since June of 1989 and a Senior Engineer in that department beginning in June of 1992. During this time, I have been responsible for many transmission planning studies including the study of our North Shore area transmission system of which this project is one feature. Prior to joining the New England Power Service Company (predecessor of the National Grid USA Service Company), I was employed as a system planning engineer at Stone & Webster Engineering Corporation for eight years.

5. Q. What is the purpose of your testimony?
A. The purpose of my testimony is to describe the need for NEP's proposed 115 kV capacitor bank additions at the Salem Harbor 115 kV Switchyard (the Switchyard).

6. Q. Have you submitted any exhibits with your testimony?
A. Yes. The exhibits are marked JWM-1 through JWM-4.

7. Q. Were these exhibits prepared by you or by others under your direction?
A. Yes, they were.

8. Q. Is the information contained in this testimony and the accompanying exhibits true and accurate to the best of your knowledge and belief?
A. Yes, it is.

9. Q. Please describe the general location of the proposed project as it relates to the existing electrical system of the petitioner.
A. Exhibit JWM-1 is a geographic map showing the approximate location of the Switchyard, located in Salem, MA. Several transmission lines are also shown on this exhibit including the 115 kV lines labelled S-145, T-146, B-154, and C-155.

Exhibit JWM-2 shows in schematic form the major transmission lines in the North Shore area, including those in Exhibit JWM-1. The Switchyard is served by two pairs of 115 kV transmission lines. The S-145 and T-146 lines run west from the

Switchyard to the Golden Hills substation in Saugus and to the Tewksbury substation. The B-154 and C-155 lines run north from Salem to the Danvers Municipal substation at South Danvers and ultimately connect to the NEP substation at Ward Hill in Haverhill. This forms half of a 115 kV loop serving the North Shore area; other transmission lines which interconnect the Tewksbury substation and the Ward Hill substation complete the loop. These lines are all part of NEP's interconnected transmission system.

10. Q. Will you describe how these transmission lines are arranged to supply energy to the North Shore area?

A. Exhibit JWM-2, introduced above, shows that there are four principal bulk supply points for electric energy to our North Shore area. These supply points are:

1. Ward Hill substation in Haverhill, with direct connections to the New England 345 kV transmission network;

2. Golden Hills substation in Saugus, with direct connections to the New England 345 kV transmission network;

3. Tewksbury substation, with 115 kV connections to the Sandy Pond substation in Ayer with direct connections to the New England 345 kV transmission network;

4. Salem Harbor Station of USGen New England, Inc. (USGenNE), with approximately 700 MW of net installed generating capacity.

The bulk supply points are located on the edges of the North Shore area. A number of 115 kV transmission lines connect these supply points and deliver electric energy to substations of NEP, Massachusetts Electric, and several municipal utilities throughout the area. From Tewksbury, two 115 kV lines, S-145 and T-146, connect to the Golden Hills substation and the Switchyard. From the Switchyard, two 115 kV lines, B-154S and C-155S, connect with South Danvers. These lines then continue as B-154N and C-155N to Ward Hill. The 115 kV G-133 line connects Ward Hill with West Methuen (through East Methuen) and then continues as Y-151 from West Methuen back around to Tewksbury. Because of its important position in the transmission loop, the Salem Harbor Station is required by NEPOOL and

REMVEC to provide an amount of voltage support on the loop. The plant does this through action of its generating units to produce the requisite reactive power to hold the Switchyard to a scheduled voltage of 119 kV (or 1.035 per unit ["p.u."] of a nominal 115 kV) with all lines in during heavy load periods.

11. Q. Please explain how you determined the need for this project.

A. The reliability standards for the New England Power Pool, of which NEP is a member, and the National Grid USA Transmission Planning Guide require that our transmission system be designed so that facility loadings are kept within capabilities and transmission equipment is kept within reasonable range of voltage for foreseeable contingencies, such as the loss of a single element like a major transmission line.

To ensure that our North Shore area transmission system continues to meet these reliability criteria, we conducted electrical system studies for the area for the period through the year 2012. These studies involved computer simulations of power flow; because USGenNE had filed an application for retirement of the Salem Harbor Station, we made sure to simulate system performance both with and without the presence of Salem Harbor generation. We simulated various contingency conditions and monitored the flow and voltage levels on the transmission lines and substation buses, checking that the flows and voltage levels on all facilities remained within their capabilities. The flow capabilities are determined using maximum allowable component temperatures as criteria. The temperatures are fixed by manufacturers' design, American National Standards Institute (ANSI) standards, known material properties, or, in the case of a transmission line, the design basis of the line. The range of allowable voltage level is fixed by manufacturers' design and ANSI standard. In cases where the simulations indicated that loading or voltage on a facility exceeded its' capabilities, we evaluated changes to the facility or the system to keep the facility within capabilities.

12. Q. What did the system studies indicate were the problem areas pertinent to this filing?

A. These studies showed that several facilities on the North Shore transmission loop would become loaded above their capabilities, under the various contingency conditions tested. These are being handled by system modifications outside the scope of this filing. However, specific to this filing, the loadflow studies showed the Salem Harbor Station provides approximately 135 MVAr of reactive support equivalent to a nominal 126 MVAr at 115 kV) under all lines in conditions to maintain the desired 119 kV transmission system voltage schedule. Without this support, the system voltage would be less than desired. This relationship is displayed in Exhibits JWM-3 and JWM-4 which are plots of reactive power demand and supply in MVAr versus per unit voltage at the Switchyard for a variety of conditions.

These plots result from a specialized form of loadflow analysis called "Q-V analysis" – "Q" for reactive power, "V" for voltage. Each plot contains a number of reactive demand curves, covering the "all lines in" condition as well as a selection of contingency conditions. Also plotted are a number of reactive supply curves, covering multiples of 63 MVAr capacitor banks. The intersection of the demand and the supply curve determines the operating voltage of the Switchyard for the resultant system. For example, from JWM-3 with zero capacitance supplied, the resulting Switchyard voltage would be approximately 0.995 p.u. (114.4 kV) with all lines in and 0.88 p.u. (101.2 kV) under the worst-case contingency. Exhibit JWM-4 shows a similar set of curves but for a system configuration which includes modifications at other points on the North Shore transmission system which NEP intends to pursue in a separate filing. In this instance, with zero capacitance supplied, the resulting Switchyard voltage would be approximately 1.00 p.u. (115 kV) with all lines in and 0.98 p.u. (112.7 kV) under the worst-case contingency. These results showed that system voltages would be less than desired with no reactive support at the Switchyard, either from the generating units or from other sources. This would lead to a violation of reliability criteria.

13. Q. Briefly describe the proposed solution to resolve these problems and why you chose it.

A. The proposed solution to these problems is to install two 63 MVAr 115 kV capacitor banks at the Switchyard to provide the necessary reactive support. From JWM-4, the resulting 126 MVAr of capacitive support will produce Switchyard voltages of approximately 1.035 p.u. (119 kV) with all lines in and 1.02 p.u. (117.3 kV) under the worst-case contingency. The proposed solution was chosen over the alternatives based on economics, reliability, and environmental factors.

14. Q. Briefly describe the alternatives studied in addition to the proposed solution.

A. In addition to the proposed solution described above, there were two alternatives studied to address the problem. Both alternatives were conditioned on a set of other modifications to handle the overloaded facilities. The alternatives required substantially more equipment than the proposed plan. Additionally, the set of other modifications proved to be more expensive as well as involving facilities on a wider ranging scale, resulting in a less robust system.

The first alternative considered the addition of six 45 MVAr 115 kV capacitor banks at the Switchyard. The smaller size was necessary due to restrictions on voltage change during switching. The increased number of banks and the higher total capacitive support was necessary to produce the desired voltage range.

The second alternative considered the addition of four 45 MVAr 115 kV capacitor banks at the Switchyard and two 45 MVAr 115 kV capacitor banks at NEP's Golden Hills substation.

15. Q. What is your opinion of the proposed location for the capacitor banks?

A. Given the combination of accessibility to multiple transmission lines, the established substation environment, the resulting system performance with a modest amount of equipment additions, and the relatively low cost associated with the proposed project, the proposed addition at the Switchyard site presents the best alternative.

16. Q. The petition filed in this proceeding asks for a determination by the Department, under Chapter 40A of the General Laws with respect to zoning exemption, that the proposed facilities involved in this proceeding are public service facilities which are necessary for the convenience and welfare of the public as required by the standards of said chapter 10. In your opinion, do the proposed facilities, which are the subject of this hearing, meet these standards?

A. I have been advised by counsel that they do.

17. Q. Does this complete your direct testimony?

A. Yes, it does.